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Evolution of Particle Size in Turbid Discharge Plumes

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LONG-TERM GOAL

The long-term goals of this research are to develop and test a particle aggregation parameterization in turbid, river, discharge plumes.

OBJECTIVES

The proposed research has two objectives. The first is to monitor the evolution of in situ and disaggregated particle size distributions in the Eel River plume during major discharge events. The second is to develop and test a simple parameterization of particle aggregation that can be incorporated directly into dynamic plume models.

APPROACH

The field effort employs a rapid response strategy, in which preset streamflow levels in the Eel River elicit a mobilization of people and gear. Within 24 hours of a "trigger," an instrument package comprising a CTD, optical backscatter sensor, silhouette floc camera (SFC), and 2 depth- actuated Niskin bottles is ready to be deployed from a Coast Guard helicopter. On a wire the instrument package is lowered into the water on a grid of 9-12 stations in the Eel River plume. The theory component of this research is focussed on development of a parameterization of the aggregation process. By assuming a form for evolving size distributions the system of coupled ordinary differential equations normally employed to model aggregation can be reduced to a single equation. Substantial savings in computational effort derive from this approach, making possible the routine incorporation of aggregation into models of sediment transport.

WORK COMPLETED

In winter 1998 particle size distributions were monitored during four flood events on 9 helicopter missions. SFC photos for each mission have been digitized. Water samples have been analyzed for SPM, and disaggregated grain size distributions have been generated with a Coulter Multisizer. A COOP student name Kristian Curran carried out flume studies to study the evolution of disaggregated

grain size distribution in a flowing suspension. Grain size distributions have been generated, and a data report is on file.

RESULTS

The Eel River plume is constrained to a narrow band along the coast. It does not flow over the flood deposit as previously expected. Up to 75% of Eel River sediment bypasses the Eel River shelf when discharge is high and alongshelf currents are strong. Flocs in the Eel River plume are always present and tend to be small ($d \leq 0.25$ mm). Flocs are larger ($d \leq 1$ mm) when wind and wave energy are low. These observations indicate that aggregation occurs rapidly within the plume, and they suggest turbulence limits floc size during storms. Evolution of disaggregated grain size distributions records time since leaving the river mouth for a parcel of suspension, providing a powerful new tool for environmental interpretation of fine-grained deposits. Finally, by characterizing aggregating size distributions with a simple Junge distribution, a reasonably accurate prediction of aggregation rate within a suspension is possible.

IMPACT/APPLICATION

Observations are helping to refine understanding of modes of delivery of flood sediment to the Eel River Shelf. Bottom-boundary-layer transport of sediment must occur to shift sediment from the nearshore plume to the midshelf flood deposit. Also, significant bypassing of the shelf occurs.

TRANSITIONS

No transitions have occurred to date.

RELATED PROJECTS

Similar observations of in situ and disaggregated grain size were made with ONR support in a turbid discharge plume in Yakutat Bay, Alaska. Collaborators are James Syvitski (U. Colorado), Ellen Cowan (Appalachian St. U.) and Ross Powell (N. Illinois U.). Control of floc size by turbulent kinetic energy is being investigated under the aegis of ONR's Coastal Mixing and Optics program. Collaborators are George Voulgaris and John Trowbridge (WHOI).

REFERENCES

- Gonzalez, E. A. and P. S. Hill. A method for estimating the flocculation time of monodispersed sediment suspensions, Deep-Sea Research, in press.
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